1871 1971

SERVICE MÉTÉOROLOGIQUE DU CANADA
CANADIAN METEOROLOGICAL SERVICE

METEOROLOGY IN BRITISH COLUMBIA:

A CENTENNIAL REVIEW.

BY
THORNE K. WON

VANCOUVER B.C. MAY, 1971

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FOREWORD

The year 1971 marks the 100th Anniversary of the Canadian Meteorological Service as a Federal Government agency. It is also the year commemorating the 100th Centennial of British Columbia joining Confederation, and so it seems fitting to review not only the growth of Canada's Weather Service across the Nation, but to tell the story of those events of particular interest to British Columbians. This has been done by Mr. Thorne K. Won, Meteorologist at the Vancouver Weather Office, ably assisted by many of his associates.

It has also become abundantly clear that we must direct increasing attention toward preserving the quality of the atmosphere. This is the challenge of the 70's and the Canadian Meteorological Service, in concert with other components of the Federal Department of the Environment will participate in achieving this goal.

We hope you find this publication interesting for its own sake, and that it will be of value, for reference purposes, in libraries and educational institutions. Copies may be obtained by writing to

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739 West Hastings Street,
Vancouver 1, B.C.

JLKnox.

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Regional [illegible],
739 West Hastings Street,
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Regional Meteorologist
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INTRODUCTION

Eighteen seventy-one - it had been four years since the provinces of Ontario, Quebec, Nova Scotia, and New Brunswick united to become one nation. British Columbia, on the west coast, was torn between allying with the distant Dominion of Canada or with the reasonably close United States of America, which had recently purchased the territory of Alaska. Finally, a decision was made to become a part of a nation which would stretch from "sea to sea", and in July of 1871, British Columbia became a part of the Dominion.

While negotiations were underway for the joining of British Columbia to Canada, Professor G.T. Kingston, Director of the Toronto Magnetic Observatory, after relentless efforts to obtain funds to organize a national Meteorological Service, finally obtained, in May of 1971, an appropriation of $5,000 from the government for such a task.

The Canadian Meteorological Service, therefore, joins British Columbia in centennial celebrations in 1971. This historical review was written to commemorate these notable events and to familiarize readers with the Meteorological Service and its progress during the past century with particular reference to events in B.C.

Since meteorological instruments have an integral role in the science of meteorology, no historical review of meteorology would be complete without at least a general discussion of instruments and their advances through the ages. The first section of this report deals briefly therefore with the evolution of the major meteorological instruments and with an important recent development---the weather satellite.

In the second and third sections the history of meteorology in Canada and in B.C. are discussed in relation to the many changes that have occurred through the years.

INTRODUCTION

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In the fourth section are described some of the truly significant meteorological events of the past century in B.C. The attempt is made not only to note the meteorological significance, but to comment on the human interest stories as well. To illustrate some of these events, a few photographs have been added in a final section.

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METEOROLOGY THROUGH THE AGES

Through the ages, man has had the desire to foretell events of importance. This urge to predict the future was often to facilitate policymaking, or to forewarn heads of state of dangers in day-to-day decision-making.

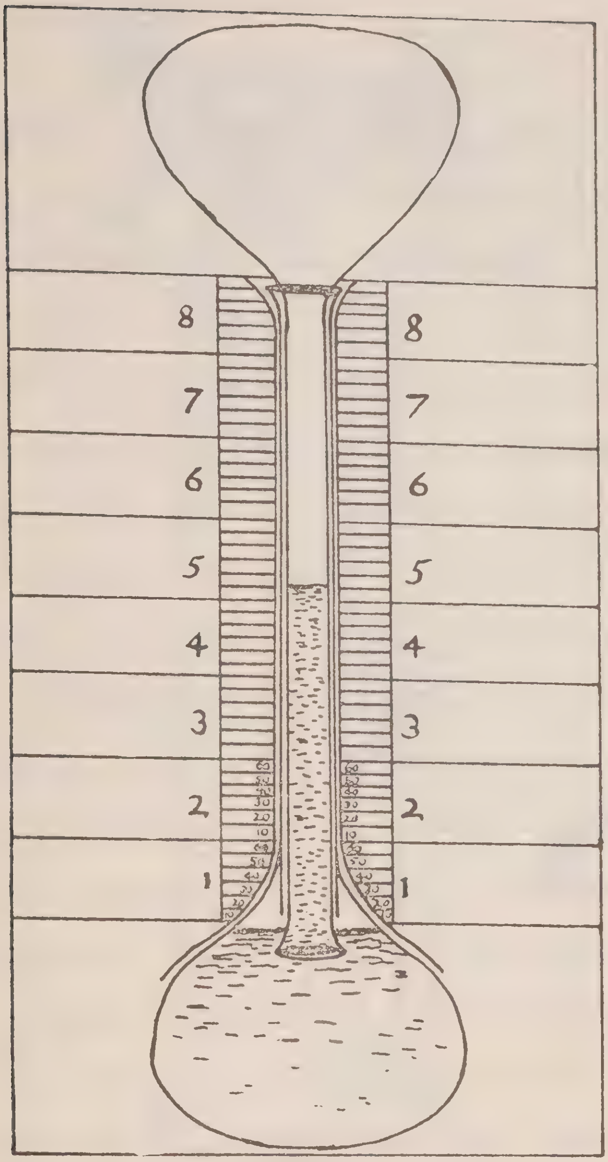
Weather has continually been the subject of predictions possibly because of its occasional awesome devastating effects and its importance to the livelihood of man. Crops which villages relied on were dependent on the weather as were the outcome of important battles. Old soothsayers were aware of warning signs of coming storms much like the meteorologists of today. Very often ancient forecasters were correct but probably as often they were wrong. Weather was thought to be due to the whim of the gods and, depending upon their moods(good or bad) weather was inflicted upon the human populace below.

Near the middle of the third century B.C. Aristotle, Greek philosopher and scholar, wrote Meteorologica where the formation of rain, dew, rainbows, and other meteorological phenomena were discussed in great detail. Unfortunately neither instruments nor systematic observing programs were available to verify his conclusions and consequently many of his explanations were incorrect. Around the same time, rain measuring devices were experimented within India where annual monsoons had an astounding effect on the crops and livelihood of the population. Wind vanes were developed as early as 100 B.C. in Greece as one in the shape of a triton was found on the top of the Tower of Winds in Athens. However, it was not until the 15th century A.D. that true meteorological instruments were developed.

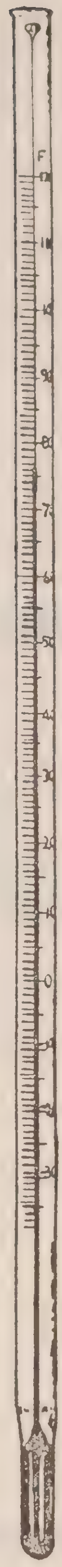
A hygrometer, a device used for measuring humidity or moisture content of the air, was invented by Leone Battista Alberti in Italy in

1450. He ingeniously used a sponge to absorb moisture from the air and used the difference in weight to indicate changes in moisture content of the atmosphere. A lull in development followed extending to the early 17th century when an air thermometer was developed, again in Italy. (see Fig. 1.1). It consisted of 2 glass flasks with the neck of one fitted into the neck of the other, and the bottom flask partially filled with water. As the surrounding air became warmer or cooler, the contained air trapped in the top flask would correspondingly expand, or contract, moving the water level up or down the graduated neck. This simple and crude instrument paved the way for the vacuum liquid-in-glass thermometer developed by the middle of the 17th century and still in use today.(see Fig.1.2). Other instruments developed at the time included several types of anemometers, devices used to measure wind speed, two of which are the swinging plate anemometer and the windmill anemometer. (see Fig. 1.3). However, the science of meteorology as we know it today was not to begin until the timely invention of the barometer.

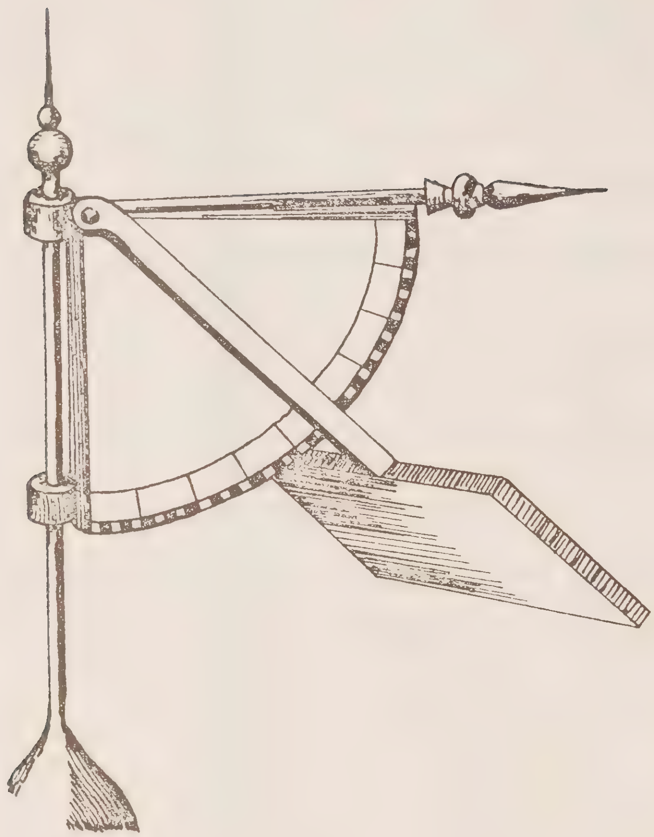
In 1643, Torricelli, who was a secretary to Galileo, discovered that the atmosphere would support a thirty inch column of quicksilver, or mercury. He explained that the weight of the mercury in the column was equal to the corresponding weight of the column of air of equal cross-sectional area. It was noted that the height of the column varied from day to day, and even from hour to hour, and that certain weather phenomena seemed to give specific low, or high, readings. Hence the barometer was relied upon as a weather predicting instrument. It is now known that atmospheric pressure is only one of several variables characteristic of different weather phenomena and the barometer, therefore, is not the only instrument



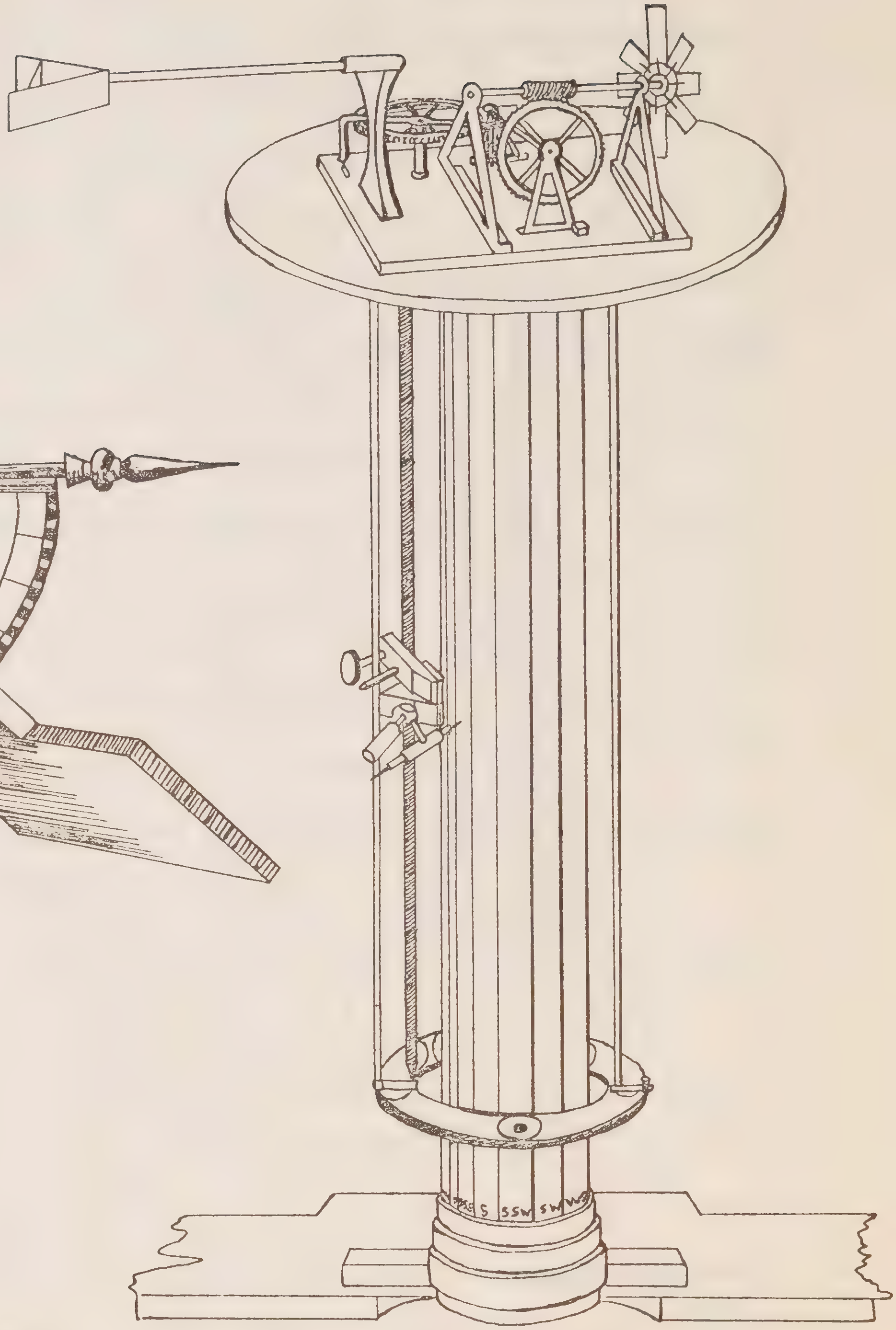
AIR THERMOMETER
Fig. 1.1



MODERN MERCURY-IN-GLASS
THERMOMETER.
Fig. 1.2



SWINGING PLATE ANEMOMETER

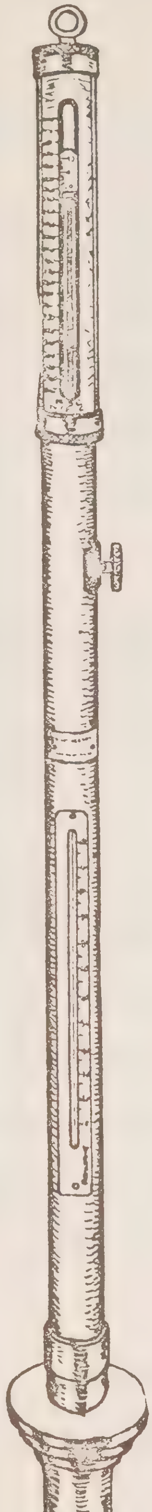


WINDMILL ANEMOMETER AND ANEMOGRAPH

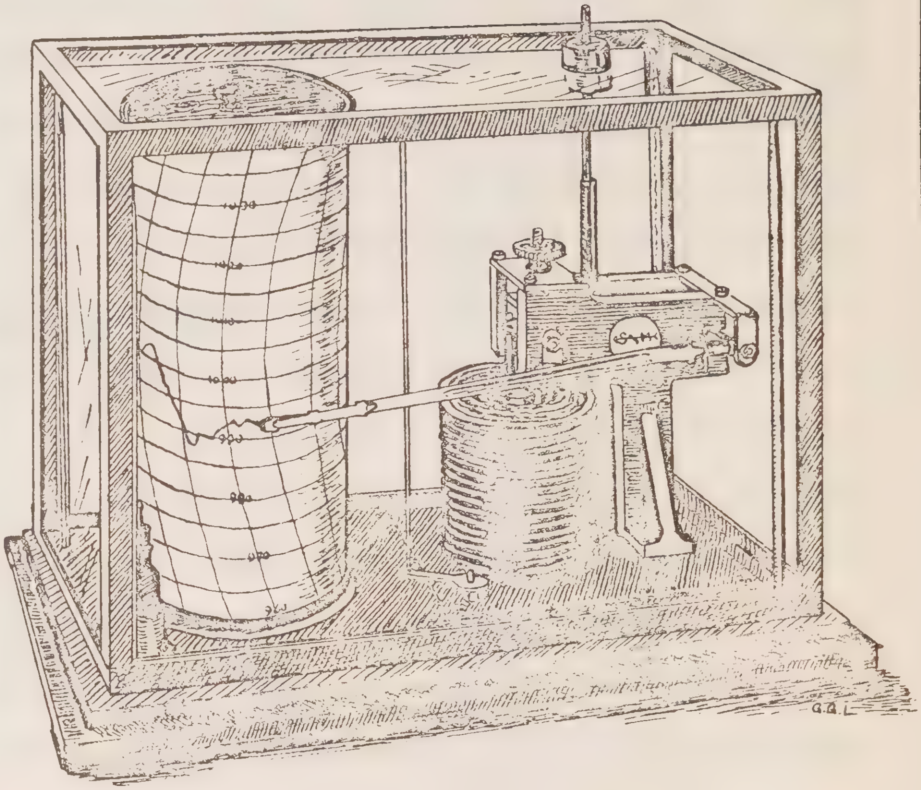
FIG. 1.3

relied upon to predict weather. Two types of common barometers are shown in Figs. 1.4 and 1.5.

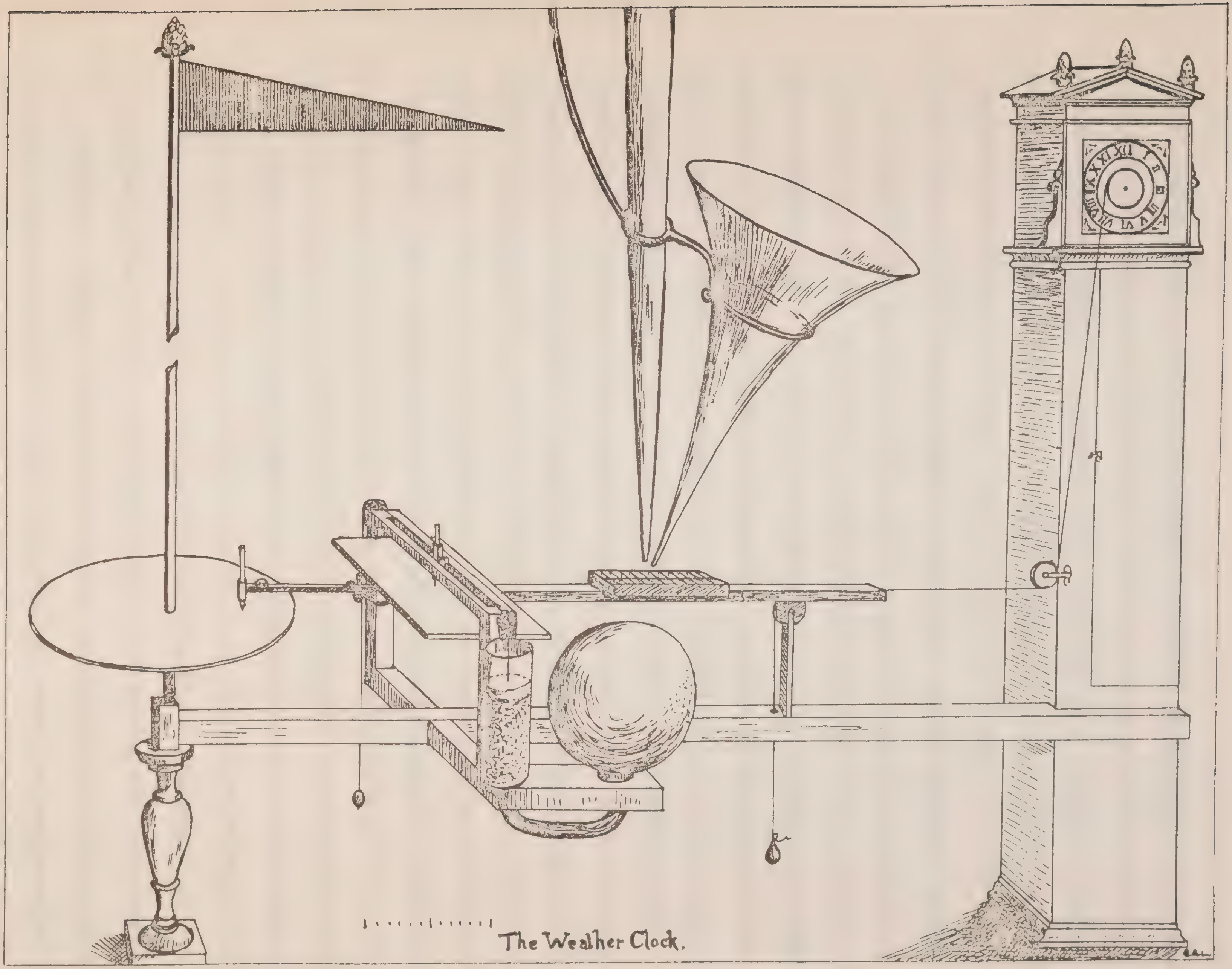
Immediately following the introduction of the barometer, meteorographs, or combination instruments, used to measure several elements over a period of time came into existence, the first of which was invented by Sir Christopher Wren. It consisted of an air thermometer, a wind vane, and a funnel to catch rainfall. A strip of paper where the state of the atmosphere was recorded was kept moving by means of a cord attached to a wooden mounting strip with the other end wrapped around a wheel fastened to a clock. (see Fig. 1.6). By means of a series of levers and pulleys a scribe was attached to the plunger of the air thermometer and another to the end of the strip tracing on a circular disc attached to the wind vane. Variations in the temperature were consequently recorded on the slow-moving strip of paper. Rainfall was measured by means of a series of buckets on the moving strip each moving successively beneath a funnel-like collector. Following Sir Christopher Wren's original meteorograph several others were developed, each being more refined than its predecessor. It was not until the 19th century, however, that the full potential of meteorographs was realized. It became obvious that to understand the motions of the atmosphere and its variations, one must probe and study not only beneath it but also within it. By the end of the 19th century, meteorographs were sophisticated enough to be carried aloft by balloons and later recovered to extract collected data for interpretation. This method, although useful in the study of the atmosphere, provided no instantaneous information on the state of the atmosphere needed for predicting the future weather conditions as the instruments were usually not recovered for weeks, or sometimes months later. For a period of time kites were used for "upper" air soundings. Instruments fastened to a kite



MODERN BAROMETER
FIG. 1.4



BAROGRAPH
FIG. 1.5



SIR CHRISTOPHER WREN'S
FIRST METEOROGRAPH
FIG. 1.6

would be carried aloft and reeled back to extract the recorded data. The information gathered would, of course, be a little more up-to-date than information recorded from balloons. This technique provided many limitations. No soundings were available under extremely calm conditions, and the ceiling of the kite, was restricted to the length of the cord. Some kites, however, reached heights of two to three miles. Kites were controlled by kite stations which consisted of a reel house mounted on a turntable in the middle of a large empty field away from telegraph lines. The house would be turned leeward and the kite line, usually piano wire, played out. Often several kites would be attached to one line, all except one being used to support the weight of the line. Normal flights lasted up to four hours. Precautions were taken to insure against electrical shocks to the operators by the static electricity accumulated on the kites, and large insulators were placed between the reel and the crank. The reel was then grounded by means of several large conductors. A shunt was provided, however, to divert the electricity through a voltmeter and readings as high as 50,000 volts were noted at times. Under extremely windy conditions, the wires would occasionally break, setting the kites free to blow across the countryside trailing lengths of piano wire. The greatest danger was the possibility of the trailing wire dropping across high tension lines. Special crews with automobiles stood by during flights to give chase and retrieve runaway kites.

Sunshine has always been related to the feeling of well being. Therefore, it was not unusual for man eventually to add sunshine statistics to his ever-growing library of meteorological data. Sunshine recorders first came into existence near the middle of the nineteenth century, and by the turn of the century some models had become so refined that they are

still in use today. Basically a simple instrument, sunshine recorders have few if any moving parts. The basic recorder in use at the present time consists of a glass ball and a strip of calibrated sensitive paper. The rays of the sun, when it is shining, are focussed on to the paper and by scorching it, provide a simple measure of daily sunshine.

With the birth of aviation, meteorology grew in importance and consequently understanding and knowledge also grew. Instantaneous reports on the state of the atmosphere aloft could now be brought back to earth almost immediately. In poor weather, however, when information was urgently required, aircraft were unable to operate. This much needed data was lost until the 1930's when the radiosonde, a meteorograph with a radio transmitter was developed enabling information to be transmitted to earth as the instruments were being carried aloft by a balloon. Pilot balloons, balloons whose rate of ascent is known, were utilized in determining wind speeds and directions aloft strictly by visual means. The drawback of a pilot balloon is obvious since any cloud ceiling would obscure the balloon from ground observers. This obstacle was eliminated after much research and development with the perfection of radar just before the Second World War.

Originally designed as a military aid in aircraft detection, and as a weapons guidance system, radar soon found its way into the science of meteorology. Basically, radar consists of a radio transmitter sending out radio signals, and a radio receiver receiving the reflected signal and interpreting it. Since radar signals, at certain frequencies, were found to penetrate cloud layers, it became evident that balloons with a fine wire netting, or trailing a foil target, could be tracked by radar under any weather conditions to determine upper wind velocities. One of the important

uses of radar today lies in its use as a precipitation detector. With a sufficiently long wave, or low frequency, radar signals may be reflected by water droplets. Thus the presence of areas of rain, snow, or other forms of precipitation could be detected along with the intensity, extent, and distance from the point of observation. Tornado spawning clouds are easily pinpointed on a radarscope due to their characteristic line, or cellular appearance as are major thunderstorms. Fortunately tornado occurrences in Canada are infrequent, but the radar is invaluable as a tool in detecting lightning and hail storms.

During and following the Second World War, science made tremendous technological advances and devices such as rockets were used to sound the atmosphere from not only within but also from above. The major breakthrough in Meteorology came in the beginning of the sixties with the successful launching and operation of TIROS I, the first United States weather satellite. For the first time, men on earth were able to view weather systems and cloud areas from above. Equipped with two television cameras, pictures of cloud patterns were taken over all parts of the earth. Weather systems could now be "seen" developing and future positions could be forecast with more accuracy. By July of 1961, a little over one year after the launching of TIROS I, the United States began international distribution of Satellite Storm Advisories on tropical storms. In September of 1962, the sixth satellite in the TIROS series was launched and for the first time two satellites were in operation at the same time. By the mid - 60's a total of ten successful TIROS satellites had been launched and had paved the way for the development of other more complex and sophisticated satellites. The NIMBUS series was launched mainly for research and development providing high resolution pictures for use

throughout the world. In December of 1966 the first of two Applications Technology Satellites, or ATS, were launched by NASA. Seemingly motionless over a point on the equator the ATS photographs an area 3600 nautical miles in radius once every twenty-four minutes. These satellites seem motionless because their period of revolution equals the earth's period of rotation. Situated in an orbit 22,300 statutory miles above the earth's surface, these satellites transmit pictures that can be pieced together to form a time-lapse picture of weather systems. The present operational satellites are of the ESSA series (Environmental Survey Satellites) and photographs from these are transmitted via the APT, or Automatic Picture Transmission, system to the 400 ground stations daily. This system provides almost instantaneous picture transmission from the satellite and hence is widely used in day to day forecasting.

To illustrate some of the potential of satellite technology in modern day meteorology a montage of photographs received in Vancouver on the afternoon of the first centennial day, 1 May 1971, is shown in figure 1.7. Immediately following in figure 1.8 is a photograph of the synoptic weather chart as prepared in the Vancouver Weather Office on the same afternoon. The clear association of cloud mass and weather front, of cyclonic cloud whirl and surface depression shows dramatically the usefulness of this space-orientated observational system.

The science of Meteorology has indeed progressed from the days of Aristotle but perhaps future developments may make our present sophisticated instruments as crude and as obsolete as Sir Christopher Wren's meteorograph.

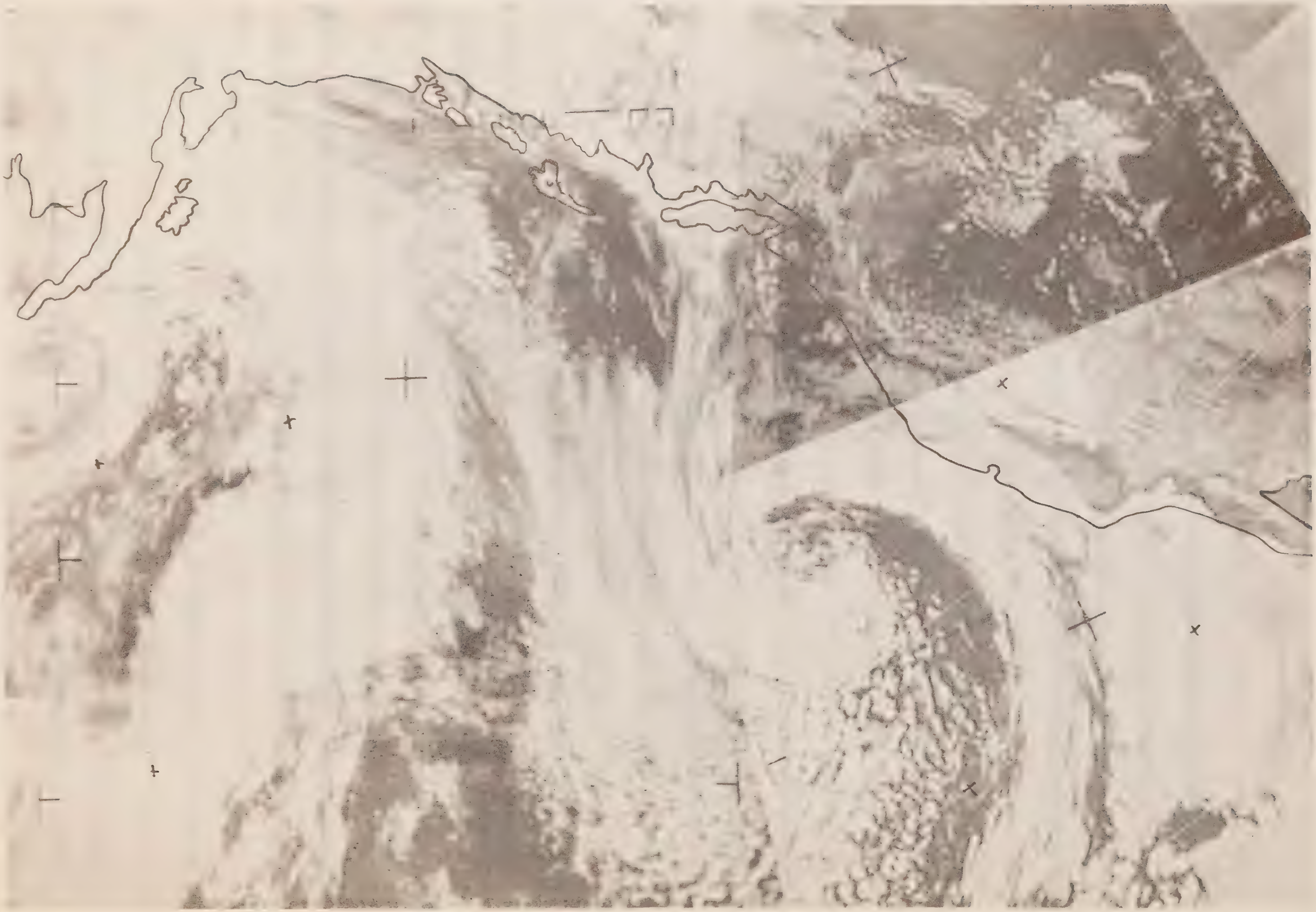


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Fig. 1·7

Fig. 1·8

METEOROLOGY IN CANADA

ONE HUNDRED YEARS OF DEVELOPMENT

In May of 1971 the Canadian Meteorological Service will celebrate one hundred years of service to the Canadian public. Although meteorological observing posts had been established by private individuals well before 1871, it was not until May of that year that the government granted funds for the establishment of an organized system of meteorological observers throughout the nation. Professor G.T. Kingston, Director of the Toronto Magnetic Observatory, in 1871, received an appropriation of $5,000 to establish such a system in Canada. The Central Meteorological Office, or headquarters, was to be in Toronto with chief stations throughout the country responsible for telegraphing regular weather reports to the head office. Other types of stations included telegraph stations and climatological stations.

The United States Army Signal Corps had established a meteorological service in the United States the previous year and had organized a number of reporting stations throughout the country. Since it was of mutual benefit to exchange weather reports, Canada was to telegraph reports from six Canadian stations to Washington and in return Washington was to send to Canada regular reports from fifteen American weather stations. Storm warnings were issued by Washington and received in Toronto for distribution to centres near the Great Lakes, but by the middle of the 1870's, Canada began issuing her own forecasts without advice from the United States. Although Toronto newspapers carried Canadian weather forecasts for Eastern Canada by the end of 1876, it was not until November of 1898 that forecasts were prepared and issued in Victoria, British Columbia, for the west coast.

After the turn of the century new meteorological stations were established throughout the country, filling many voids where lack of weather

information had hampered forecast accuracy. Upper air research was begun, and its importance steadily increased with the growth of aviation. Military strategy during the Second World War raised many difficult questions and meteorologists strived relentlessly to solve these knowing that the eventual outcome of that conflict might depend on the knowledge of meteorology. The war effort spurred the development of meteorology in Canada and by the end of the war many new techniques had been innovated. Weather stations on both the Pacific and the Atlantic, and five Arctic Weather outposts, were established during the immediate post-war years. Prior to 1945 public forecasts were issued only at Toronto and Victoria with Toronto responsible for all areas east of the Divide. At the end of the war, offices at Vancouver, Edmonton, Winnipeg, Toronto, Montreal, Halifax and Gander were made responsible for public, as well as aviation, and marine forecasting for their respective areas. Facsimile circuits enabling the transmission of charts, photographs, and other pictures, had been perfected, and by the early fifties regular transmission of weather charts from Montreal had been established.

At the present time the Canadian Meteorological Service is not only responsible for the writing and issuing of forecasts, but also for many specialized and beneficial research and operational programs. Air pollution is one of the major problems of today and much research is being performed in that field. Ice observing and forecasting, invaluable to shipping during the winter and spring months, is also part of the program. Other fields include: agrometeorology, hydrometeorology, microclimatology, urban climatology and, of course, upper air climatology. Although research is being conducted in the fields mentioned, forecasting remains a basic and well known function of the Canadian Meteorological Service. It seems ironical that when Sir Frederic Stupart, later to become Director of the Meteorological Service, and Mr. B.C.

Webber, first proposed the issuing of weather forecasts in the early 1870's, the proposal was opposed by the Royal Society of London which, at the time, attempted to influence the Meteorological Service in Canada on the grounds that "...forecasts are unscientific and it is contrary to all scientific etiquette to issue conclusions before verification."

The present annual cost of the meteorological service to Canadians is about fifty million dollars which, in terms of dollars spent by the government, is a long way from the five thousand dollar grant in 1871. With the present population, the cost of this daily service, holidays included, amounts to slightly more than two dollars per person annually! Communications circuits have been extended to over fifty-seven thousand miles and all teletype traffic is computerized for a more efficient operation. There are almost three hundred principal synoptic stations in Canada, and weather reports are exchanged for several thousand international stations. A significant part of the annual budget is utilized in the distribution of educational materials, lectures, displays and exhibits, publications for public information, and specialized services to private organizations.

Progress will continue to be made in the Meteorological Service as new fields of research are found and better methods are discovered to facilitate more accurate and longer range forecasts.

METEOROLOGY IN BRITISH COLUMBIA

Well before the Federal Government decided to support financially a meteorological service in Canada, the Royal Engineers had established several meteorological observation posts throughout British Columbia. Realizing the importance of weather information, the Engineers recorded data on temperature, precipitation, and air pressure at select locations. New Westminster, the capital city of British Columbia, which was then separate from the crown colony of Vancouver Island, was the main centre and the headquarters for the Engineers. Other organizations, including the Hudson's Bay Company, maintained meteorological records at various settlements. The records at Victoria from 1880 to 1890 were kept by an official of the trading company.

Government supported meteorological services began very inconspicuously in British Columbia with a station at Spence's Bridge on the Thompson River. This station was an Engineer outpost and was responsible for making weather observations three times daily measuring temperature, wind velocity, precipitation, and associated weather phenomena. With an increase in government expenditures Spence's Bridge was made a chief station, and a second government station was established at Esquimalt near Victoria with observer W.H. Bevis in charge. The superintendent at Spence's Bridge was John Murray, and with the increase in station rank the duties, which involved taking observations no less than eight times daily, correspondingly increased. The station at Esquimalt was established in the interest of shipping as the Esquimalt harbour was considered as one of the finest natural harbours on the west coast. With the Royal Engineers already observing at New Westminster, the task of establishing an official observing station was relatively simple and under the supervision of Captain Adolphous Peele, of the Peele Rifle Butts, New Westminster was officially declared a meteorological station in 1874.

With the three main stations in operation, several smaller stations

were enlisted with little or no government support; the duties of the smaller sites being the relatively simple task of recording temperature extremes and precipitation amounts daily. With no forecasts to issue, the officers at the meteorological stations compiled information of only what was happening.

The weather records made by Captain Peele are kept at the Vancouver Weather Office. Beautifully scribed in ink on delicately ruled paper, tinged yellow-brown around the edges, are meteorological data recorded as far back as 1873. Barometric pressure recorded to the nearest one hundredth of an inch was standard practise then. Rainfall, snowfall, maximum and minimum temperatures were recorded and the height of the freshet, or river, during the flood season was also noted. Adjectives used to describe weather conditions at the time were colourful, although by today's standards they may be considered unscientific. "Gloomy" denoted dark, overcast skies while "very gloomy" almost certainly meant a bad storm. Often the sky condition was described simply as being stormy. Along with weather observing, and water watching during the flood season, Captain Peele also noted times of appearance of birds such as swallows in spring and the times of fish runs in the Fraser River.

The Royal Engineers, in their roadbuilding expeditions through the southern interior, established several meteorological observing posts throughout the area. Stations were established east of Spence's Bridge at Nicola Lake and at Douglas Lake. Kamloops, situated at a strategic junction of the North Thompson and the South Thompson Rivers was an important fort on the fur brigade trail and saw increased activity when news of gold in the Big Bend country broke. An observing post was there during the late 1870's. Prior to the news of the gold in the Kootenays, gold fever reached a peak in the Cariboo country. With the Cariboo trail completed in the late 1860's, men sought instant fortune in the gold fields. Barkerville, named after a persistent young Cornishman, Billy Barker, became the centre of one of the richest strikes in the area and, almost overnight,

the settlement grew to be one of the largest towns west of Chicago and north of San Francisco. After the gold petered out, and after a disastrous fire which almost completely destroyed the community, the population became transitory and only a few settlers remained. In 1888 a meteorological station was established at Barkerville under the supervision of Dr. Hugh Watt. Observations of daily temperature extremes and precipitation amounts were initially taken, but hourly records were kept after the turn of the century. Other stations on the Cariboo Trail included Soda Creek and Quesnel.

During the first decade of operation of the Canadian Meteorological Service almost twenty meteorological observing stations were established in British Columbia with most of these measuring only temperature or precipitation, or both. Although forecasts were being issued for Eastern Canada at Toronto, it was felt that there were insufficient observations on the west coast to permit a like service for residents of Western Canada during the first two and half decades after the Meteorological Service was conceived. Mr. C. Carpmael succeeded Professor Kingston as Director of the Meteorological Service when the latter retired in 1880. As the new Director, Mr. Carpmael continued to expand the Service. Esquimalt was established as the chief station in British Columbia in the charge of Mr. E. Baynes Reed in 1890, and six observations were to be taken daily with two telegraphed to Toronto. This new station was second only to Toronto as far as instrumentation and other equipment were concerned.

Weather forecasts became increasingly the subject of concern among many residents of the coastal cities but officials of the Canadian Meteorological Service were still reluctant to authorize their issue on the west coast. Petitions were circulated among the merchants in Victoria requesting the issuing of storm warnings since their businesses often depended upon the

safe arrival of ships carrying goods from San Francisco and the Orient. The main obstacle, stated the government, was the increase in expenditure necessary for such a service. The increase was estimated at roughly $5,000 per year! Twenty years after forecasting began in the east, the Meteorological Service finally approved the appropriation of funds to be used to set up a forecast service to residents of the west. Sir Frederic Stupart, who had become Director of the Meteorological Service in 1894, travelled from Toronto to Victoria to finalize arrangements. Signal sites in both Vancouver and Victoria were chosen and a suitable building to house the instruments, as well as the forecast office, had to be selected. The old customs house on Cook Street was found to be adequate and the instruments from the Esquimalt station were then installed at the new site. Reports were to be sent daily from stations as far away as Port Arthur, Ontario and Chicago, Illinois, and the collected data plotted on surface charts and analyzed. In charge of the operation at Victoria was E. Baynes Reed, who was the superintendent at Esquimalt. Mr. Napier Denison, an experienced technician, was sent from Toronto to assist Mr. Reed in his new operation. On November 1, 1898, five months after the approval of forecast services for the west coast, the first weather forecast appeared in the Victoria newspaper, the Daily Colonist, and in March of the following year storm signals were first put into operation. By use of a drum and a cone during the day and two lanterns at night, a series of signals were devised to warn mariners of pending storms. Thirty-six hour forecasts for the expected wind conditions were received by the harbourmaster, and the corresponding signal was hoisted. Captain McLeod, harbourmaster for the port of Vancouver explained in the March 14th, 1899 issue of the Province newspaper that "...signals are merely cautionary: they only indicate that a storm is within a day's sailing from the point where the signal is displayed and not necessarily in the very neighbourhood itself." In addition to issuing weather

forecasts and recording climatological data, the meteorological service was also responsible for giving correct time signals, determining correct latitude and longtitude, as well as drawing charts of isogonic lines of magnetic declination in Canada. Another field included in this service was seismology. A Milne seismograph was placed at Victoria in 1897 and continuous records of earthquakes were then recorded and forwarded to centres of seismological research throughout the world.

By the turn of the century there were almost 75 meteorological stations in operation in British Columbia, many of which are still in operation today.

The Victoria Weather Office, initially in the old customs building, was moved to the post office building on Government Street in 1899 and remained there until a permanent site was selected. In April of 1912 a new meteorological station was proposed for Victoria, and again Sir Frederic Stupart paid the capital city a visit. Consulting with the Victoria Board of Trade, Sir Frederic decided in favour of a site on Gonzales Heights. Two years later construction began on solid rock on the hill overlooking the Straits of Juan de Fuca. A well-constructed building of concrete was erected on the site and new instruments were installed. Since seismology was considered a part of meteorology, probably because the realm of earth sciences encompassed both, seismographs were placed in the basement of the station where the mounting and sensing rods may still be seen today. A precise chronometer, estimated at 130 years of age but accurate to one tenth of a second per day, was used to maintain a record of correct time for the seismological data. The old grandfather clock can still be found at the station. A dome for housing a telescope was placed on the roof of the building as astronomy was also considered a part of meteorology. The building was officially opened on April 23, 1914, and observations began immediately. Mr. Napier Denison became officer-in-charge of the Victoria Office following the death of

Mr. E. Baynes Reed in November of 1916, and continued his colourful career advancing the science of meteorology in Victoria until his retirement in 1936.

The Meteorological office at Vancouver was officially opened in 1905 under the direction of Mr. T.S.H. Shearman, the official observer. Following the retirement of T. Shearman, in 1915, the duties were assumed by his brother E.B. Shearman, who continued in this capacity until his retirement in 1948. The original site was on West Fifth in Kitsilano but was moved to the West End in 1934. Although there are now several climatological stations in Greater Vancouver an extension of the original program started in 1905 and is still carried on at the Winch Building in downtown Vancouver.

Public weather forecasts were issued in Victoria after 1898 for the west coast area, based on weather charts which were prepared from reports received twice daily from across the continent. With a greater knowledge of meteorology more specialized forms of forecasting became possible. Due to requests by the British Columbia Fruit Growers, and the Penticton Board of Trade, a frost forecasting unit was set up in the Okanagan during the spring of 1935 by two meteorologists, Mr. A. Thomson, and Mr. D.C. Archibald. Nightly broadcasts giving expected minimum temperatures, and the time of minimum, at selected locations were made. Farmers were no longer required to sit out in their orchards tending heaters all night. Instead they stoked the fires only when the temperatures endangered their trees. Convection currents generated by the heaters, and direct heat from the burners, raised temperatures in orchards as much as 12 degrees. This special forecast service, continued to the present time, is provided from the beginning of April to the end of May, the critical time for fruit trees.

With the advent of commercial air travel, during the late thirties, an entirely new type of forecasting was needed. No longer were forecasts of

"sunny" or "cloudy" sufficient. Special aviation forecasts on a regular basis were initiated to meet the demands. These special forecasts predicted cloud height and extent, as well as surface variables such as visibility and wind velocity. Weather offices situated at main airports across Canada were established for the purpose of issuing route forecasts, or forecasts along the main airways, for use by commercial airlines. A complete understanding of enroute weather was a necessity, especially through the mountains where an aircraft lost in bad weather almost certainly meant a disaster. Since almost all weather occurs below twenty-thousand feet, and very few aircraft were able to maintain flight above that altitude, it was not often that planes could climb above poor weather conditions. In addition to the route forecasts, terminal forecasts, or predictions of weather conditions at individual airdromes, were issued. These were required both for planning and safety of flight operations. Accuracy never before required was necessary, and consequently a greater knowledge and understanding of the physics of the atmosphere was needed. As a result qualifications for forecasters were increased, and a university education became a prerequisite.

One of these special airport weather offices was opened at Vancouver Airport on Sea Island in the Municipality of Richmond in 1935. T.H. Ryan was the first official weather observer. In May of 1937 A.R. McCauley, a new-generation meteorologist, arrived from Toronto to establish the aviation forecast service to support the fledgling Trans Canada Airlines. In September of 1937 the first forecasts were issued for the route to Seattle while by the spring of 1938 flight forecasts for the Vancouver-Lethbridge segment of the new national air operation were being regularly prepared.

Shortly after the beginning of Canadian involvement in the Second Great War, public weather forecasts were suspended in the interest of national security. It was felt that the prediction of weather conditions could have

been useful to the enemy and thus threatened the nation. Military air operations reached a peak during the war years with the ferrying of supplies and the training of aircrew. Aviation forecasts continued to be issued for the military and for commercial airlines. To meet the military requirement another forecast office was established at Western Air Command, located in Belmont House in Victoria, which issued forecasts for the B.C. Coast. By early 1943, this office was transferred with Western Air Command to Jericho in Vancouver and forecasts were then issued on a regular basis from the Vancouver site. With supplies and men continually being flown to Alaska for final preparation before being transferred to the far east, an intermediate base was required in the central interior of the province. Prince George, which had since 1929 become the main Cariboo centre after operations were transferred from Barkerville, was the ideal location. Finally in 1944, at the request of the United States Air Force, a forecast office was established at Prince George to support air transport operations into Alaska. This office which was assigned airways forecast responsibility for the northern B.C. interior was closed in 1945 as the war drew to an end. To aid forecasters in obtaining a greater accuracy in forecasts, a more complex network of reporting stations was required throughout the province. About forty such reporting stations were established during the war years. With tremendous advances in aeronautical technology, it became evident that the lack of meteorological knowledge above twenty thousand feet necessitated the dispatch of many high flying aircraft into areas of virtually unknown conditions. Since upper air data was urgently required for the successful operation of such aircraft, an upper air, or radiosonde, station was established in 1943 at Prince George by the American forces. By 1944 this station was manned by Canadian personnel and another upper air station opened at Port Hardy on the northern end of Vancouver Island. Radiosonde ascents were taken twice daily at the stations and their recorded data compiled and distributed for interpretation by meteorologists.

At the end of the war there was a need to again provide a public weather forecast service. Using an organization that had expanded tremendously to meet the demands placed upon it by aviation - civil and military, a new public forecast system for Canada was devised. In B.C. the responsibility for providing this new service was assigned to the Western Air Command Office and the first of the modern-day public forecasts was issued in 1946. In 1949 the two offices in Vancouver were amalgamated at Vancouver Airport and the combined Vancouver District Aviation and Dominion Public Weather Office was assigned the responsibility for providing a general aviation and public weather program for B.C. Although names and procedures have changed this arrangement holds today.

Weather systems generally travel from west to east. Consequently storms striking British Columbia usually have a history of travel over sections of the Pacific. The lack of information over the ocean at times prevented adequate warning of impending disturbances. During the latter years of the war a weathership station in the Pacific, off the British Columbia coast, was manned. Named station "Sunflower", the lonely post was manned by the ship "Woodstock" which transmitted weather reports at regular intervals in code to Vancouver. These reports included upper air soundings taken from radiosonde ascents from the ship. Shortly after the war the station was abandoned. In 1947, however, under the sponsorship of the International Civil Aviation Organization (I.C.A.O), a civilian weathership service was inaugurated for the North Pacific, operated jointly by Canada and the United States. The commitment became solely a Canadian responsibility in November of 1950 and former Navy frigates, the "St. Catherines", the "Stonetown", and the "St. Stephen" were converted for weather observing duties. Situated at 50 degrees north latitude and 145 degrees west longtitude, the ships gathered information on winds, temperatures, pressures, and humidity, as well as visibility, precipitation and upper air data to be transmitted to Vancouver for compilation. These

ships continued at their post until 1968 when two ultramodern weather-ships, the "Quadra" and the "Vancouver" specially constructed for the job, took over the station.

The most unusual feature of these new vessels to the casual observer is a large dome just ahead of the funnel which houses a highly sensitive radar capable of tracking balloons to heights of over 100,000 feet to determine upper wind velocities. This complex and costly instrument is also capable of detecting precipitation within a range of 200 miles and regular radar precipitation reports are filed by the on-station ship in addition to the regular surface and upper air observations.

In beautiful, green British Columbia, the forest industry rates among the top industries of the province. Each year, because of natural or human causes, millions of dollars of valuable timber are lost by fire. The British Columbia Forest Service, and the Meteorological Service, recognized this problem and began working jointly to alleviate the situation. In the early fifties a new service was inaugurated during the fire seasons. A fire weather forecast was added to complement the regular public forecast. Concentrating mainly on temperatures, humidity, and probability of precipitation, the forecasts were geared to the forest industry. With specialized techniques, and a greater network of reporting stations, a separate forecasting unit was established in the mid-sixties solely for the prognostication of fire weather. This service is utilized by the many lumber companies, who are as interested in preserving the forests as the Forest Service, for general planning during the fire season. Because of the very explosive condition of the forests during the daylight hours in times of high hazards, companies may enforce an early work period where loggers may work only during the pre-dawn hours. The British Columbia Forest Service uses the forecasts in instituting forest closures and other precautionary measures should the hazards become critical. Many operations are dependent on the forecasts

issued by the weather office. Slash burning, or the burning of waste materials is scheduled only if conditions are favourable. Each forecast includes a synopsis in plain language describing the weather situation affecting the area of concern. Disturbances, fronts, high pressure areas and other significant weather-producing phenomena are discussed briefly. A spot forecast involving the prediction of temperatures, humidities, wind speeds, and probability of precipitation at several select locations is included in the fire weather forecast. All the above mentioned variables contribute in some way to the fire hazard situation. Special phenomena such as lightning, which may trigger flash fires, are also forecast. Issued twice daily with additional forecasts during the slash burning season, the fireweather prognoses serve the forest industry well.

Because of a need for greater accuracy and higher efficiency in the writing of forecasts, a three-level forecasting system was implemented during the early sixties. In it raw information is refined in three steps to give a product for public dissemination. The initial step in the production of the weather forecast is undertaken by the Central Analysis Office located in Montreal where meteorologists interpret data transmitted from all parts of the world and, in conjunction with sophisticated computers, analyse and prognosticate synoptic changes on a national scale. The finished charts are then transmitted by facsimile circuits to offices throughout the country. Meteorologists staffing regional Weather Centrals receive the prognostic charts and, utilizing their knowledge and skills attained from many years of experience in an area, tailor these charts to suit the needs of their own region. The tailored charts are then distributed to weather offices throughout the region who handle the final step in the "manufacture" of a forecast for public consumption. Meteorologists at these offices consider local conditions such as mountains, lakes, orientation of valleys, proximity of large bodies of water,

and many other factors which govern local weather conditions. After the last refining process forecasts for distribution are written. In addition to the well-known public forecast, predictions are also issued for specialized fields such as aviation, marine, forestry, agriculture, etc. Public forecasts are issued three times daily with three separate forecasts for marine purposes. During the winter months a mountain forecast for the benefit of travellers, skiers, and highways department personnel is issued. Forecast freezing level, winds aloft, and probability of precipitation are all included in this specialized prognosis. Its opposite number during the summer months is the farm forecast issued to provide the farmer with a guide to better schedule his work during the growing and harvesting season. Aviation forecasts for the benefit of both commercial and private pilots are issued once every six hours and include expected weather conditions up to twenty-four hours in advance. Expected changes in weather conditions are forecast to the nearest hour. Forecasts are distributed locally, nationally and internationally over meteorological circuits and are available through many weather offices and over press circuits for distribution to the public by television, radio, newspaper, and telephone. In addition to the issuing of forecasts, meteorologists also provide consultation services to groups and individuals requiring specialized services. These may include teachers, students, construction companies, or individuals planning vacations. The services provided by the weather office are numerous and the information given is most often invaluable to the user.

Tremendous advances were made in the field of space technology during the late fifties and early sixties and, with the timely development of the weather satellite, meteorologists were at last able to witness the plan view of developing storms over vast areas of empty ocean, or unpopulated land. When the United States Weather Bureau installed a satellite tracking unit in Seattle to receive signals transmitted by the orbiting space vehicles, a special landline was obtained to lead the signals to a slave unit installed

at the Vancouver Weather Office. Photographs showing cloud patterns characteristic of developing storms, or impending good weather, are received daily in Vancouver. An independent tracking unit, planned for Vancouver in the very near future, will enable the signal to be received directly from the satellite thus eliminating interference and malfunctions which sometimes occur in the circuits between the two cities. The received signals recorded on magnetic tape will allow reproduction at any time. Although photographs are received only once daily, they have proven to be invaluable in the preparation of forecasts.

Completely automatic weather reporting units became a reality during the mid-sixties and in 1967, a unit was installed at Gonzales Heights in Victoria. Reporting temperature, dew point temperature, wind speed and direction and accumulation of precipitation at twenty minute intervals, the MARS, or Meteorological Automatic Reporting Station, is completely self-contained and requires only regular maintenance. This makes the units ideal for placement at remote locations where weather information is not available due to lack of personnel or facilities. The latest station provided with a MARS unit is Clinton, in the Cariboo region, which in addition to reporting the above mentioned parameters is also capable of recording and transmitting a measure of cloud cover and visibility. The voids, where weather information has hitherto been unavailable, are gradually being filled.

With air pollution a major problem of today's cities, it is only fitting that considerable research be devoted to this subject. Atmospheric conditions have a direct bearing on the amount of atmospheric pollutants suspended in the air at any one time. Therefore the state of the atmosphere, especially at low levels, must be understood clearly before any attempt to study air pollution is made. Variations in atmospheric conditions are so irregular in the lowest few hundred feet that instruments at the surface cannot measure accurately parameters aloft. Consequently, towers several

hundred feet in height have been installed at various locations in Canada to study airflow, temperature variation and other atmospheric parameters in attempts to understand the state of the lower levels of the atmosphere more thoroughly. Being one of the major industrial sites on the west coast, Vancouver is rapidly becoming an air-polluted metropolis. A meteorological tower 300 feet in height is being planned for a location in the Greater Vancouver area. Through studies made by the use of such a tower, factories and mills can build emission stacks high enough to penetrate inversions, or layers of increases in temperatures through which pollutants cannot escape.

The Service in British Columbia has made great advances during the past one hundred years, and at least as much can be expected for the second centennial. Much knowledge has been accumulated during the last century in British Columbia with regard to weather forecasting but there is much to learn. With greater advances in technology and experience, forecasting will continue to increase in quality and accuracy.

B.C. WEATHER RECALLED

(1) A Winter of Destruction

Christmas of 1934 was a typical west coast Christmas, relatively mild and wet. Temperatures ranged from the thirties to the forties along the coastal sections of the province, but freezing temperatures covered most of the Interior. Extremely high winds greeted southwestern British Columbians on Boxing Day, and Victoria recorded a sustained wind speed of 74 miles per hour on the 26th, a record which still stands today! With the intense storm moving inland, cold air was drawn out on to coastal regions from Interior valleys and, combining with the moisture available from the storm, covered most of southwestern B.C. with snow. Deliveries throughout the Fraser Valley were made on sleighs as motor vehicle traffic was completely paralyzed. Over twenty-seven inches of snow fell on Campbell River on Vancouver Island in a period of twenty-four hours as the moisture-laden cool air rushing out of the mainland inlets crossed the Straits of Georgia released its load upon striking the coast of the Island. To the delight of most of the residents, the weather moderated quickly and, by the New Year, practically all traces of the snow had melted, and once again southwestern B.C. enjoyed "banana belt" weather. Temperatures during the day neared the fifty degree mark, and night time temperatures dipped to the high thirties. The elation on the part of the coastal residents was short-lived however, as King Winter again descended upon them during the second and third weeks of January. Temperatures fell to the high teens during the nights, and barely managed to climb to the mid-thirties during the day as the cold weather settled into the area. Snow fell over most areas during the second week with about 10 inches falling on Vancouver on the 10th, 11th, and 12th. More snow fell on the 15th, 16th, and 17th, but it was the fall on the 20th that immobilized Vancouver and most of southwestern B.C. In

Vancouver the minimum temperature on the 19th dropped to 4.3 degrees, the lowest temperature of the winter. Surrounding outlying districts reported lower temperatures with the Aquarium at Hastings Park reaching two below, and Brighouse Town Hall in Richmond just a shade lower at two and one half below. Lonsdale and other sections in North Vancouver recorded eight below, and Grouse Mountain gave a temperature of 10 below. Traffic on the old Granville Street Bridge was snarled for hours when the swing span froze while open to allow the passage of a derrick.

In Victoria hundreds of water pipes were frozen, and a shortage of fuel was evident, not only because of limited supplies but also because of the difficulties the fuel companies faced in trying to cope with the increased demand. Consequently, meals were cooked in fireplaces in many Victoria homes. The C.P.R. steamship "Princess Elizabeth" reached Victoria's Inner Harbour from Vancouver with a coating of ice on her decks.

With temperatures hovering near the zero mark, and in some cases below zero, anyone with much less than 20 pounds of heavy woollen undergarments and a complete winter outfit, would be foolish to venture out into the frigid air. Pete Pantages and Johnny Gates of Vancouver thought otherwise, however, as they continued their daily habit of going for a swim in English Bay. It was a general consensus of the few interested spectators that the frigid dip was of a much shorter duration than usual.

Ice on the Fraser River forced many sawmills to close and dynamite was used in futile attempts to break up the ice. Further up the Valley snow and whistling east winds kept all thoroughfares blocked. Snowplows were useless as winds continually filled plowed sections as soon as the machines passed. The cold weather was general throughout the province as temperatures in the Okanagan plunged well below zero. Penticton reported

a maximum temperature on the 20th of one degree below zero!

With a deep layer of cold arctic air stationary over southwestern B.C., moist air from the Pacific rode over the frigid air and released its moisture in the form of snow. A total of seventeen and a half inches plugged Vancouver on the 20th, closing schools, mills, businesses and paralyzing all traffic. Cars were abandoned as drivers could make no headway against the unyielding drifts. Streetcars, jammed full with commuters who ordinarily drive their own vehicles, became snowbound and were left on the streets. Businesses closed because few people dared to venture out in the three to four foot snow drifts.

While Vancouverites were wading through a mere two-foot snowfall, residents of Princeton had to contend with a 63 inch fall! Sections of the Interior reported tremendous snowfalls as 3,000 people in the Bridge River area were isolated as a result of 35 miles of road being under 10 feet of snow. Nelson reported 12 feet of snow with a minimum temperature of 17 below. The rest of the Kootenays was buried under 4 feet of snow. In the Cariboo, residents of Williams Lake found themselves digging tunnels in order to exit from their homes. Needless to say, all roads in the area were impassable as temperatures throughout the area hovered around the 50 below mark. A P.G.E. train, caught in a slide near Pemberton, was snowbound for several days.

Finally mild Pacific air returned to the region and the cold arctic airmass retreated rapidly, leaving in its wake a snow-covered region in the throes of a quick thaw. In Victoria the temperature at noon on the 20th stood at a frigid 22 degrees. By midnight the mercury had leaped to 37 degrees, and by the time most Victorians had finished their breakfast the thermometer was reporting a balmy 47! In less than 20 hours the temperature had risen 25 degrees! Vancouverites were not to

be outdone - the minimum temperature on the 20th was 5 above. The maximum temperature the very next day had soared to 43! This sudden moderation of temperature led to a quick departure of the white paralysis which in turn presented another, and possibly more serious, problem. Torrential rainfalls descended upon the area for several days following the rapid departure of King Winter. Many roofs succumbed to the tremendous weight of accumulated snow and water; among them, the Forum roof in Vancouver at a loss estimated at $70,000. In Victoria a roof leak at a stationery store caused employees to wade through two inches of water in the store when they arrived for work in the morning. Owners of another office in the capital city bored a hole through the roof to help relieve the pressure of the accumulated snow and water. A number of small craft moored at Coal Harbour sank and several boat sheds collapsed under the strain of the heavy wet snow.

The Lower Fraser Valley did not escape. Vestiges of the rapidly retreating cold arctic air remained in the Valleys forming "pools" of frigid air. As the warm Pacific air flowed over these "pools" and released its moisture, the liquid drops froze on contact with objects within this natural freezer and the valley assumed a fantasy-like scene of glistening glaze. As beautiful as it was devastating, the ice coated everything from roads to telegraph wires and trees. Boughs snapped under the tremendous weight, reminding residents of artillery fire during the war. Soon telegraph and telephone wires were a tangled mess as poles as well as wires gave way to the ice. Many orchards were ruined as trees were stripped clean. In some places, four or five feet of snow were covered by an inch thick layer of icy glaze. There soon was a shortage of forage for cattle as all pasture land was locked in a prison of ice. Barns and many older homes unable to support the extra burden collapsed, in many cases leaving families homeless. With communi-

cations wires down, the west coast was isolated from direct contact with the east. Only urgent messages could be sent and that was accomplished by transmitting the messages via Australia on the undersea cable which was the only communication link left open from Vancouver! The moderating weather and torrential downpours introduced Vancouverites to flooding never before experienced on this west coast city. In the four days following the departure of freezing temperatures over ten and one half inches of rain descended upon Vancouver. The final accumulated total of precipitation of 20.65 inches for the month of January surpassed all monthly records and stands today. It is interesting to note that 3.81 inches of that total fell as snow for a total snowfall of 38.1 inches. The average January precipitation in Vancouver is only 8.44 inches while the annual average stands at 60.23, barely three times this phenomenal January accumulation.

Homes in the Point Grey area were seriously threatened as canyons gouged out by streams, undermined foundations. In Victoria conditions were less severe but the effects of the quick thaw and heavy rainfall were evident. The January precipitation in Victoria measured 13.28 inches compared with the average of 4.39 inches. Low lying areas throughout the city were under water with the Shelbourne and Haultain section of the city especially hard hit. Approximately 200 homes in the city reported flooded basements and deliveries were being made by rowboat. Other sections of the city affected included the Burnside-Island Highway intersection where cables were installed to haul water-logged cars through the two feet of water at the intersection.

With the disappearance of the snow drifts and frigid temperatures new dangers faced train crews and other railway employees. Mud and rock slides began along the main lines further delaying the already tardy trains. Over the lower mainland, an aerial view would give the viewer the

impression of land areas being inundated by the sea as Lulu Island was a series of lakes with Lansdowne and Brighouse race tracks completely under water. Kingsway was the only usable highway between Vancouver and New Westminster after River Road went under water. Further to the east, the Pacific Highway just south of Cloverdale was under two feet of water immobilizing all traffic in that part of the valley.

Only minor amounts of rain fell after the 26th of January and most areas began mopping-up operations. The month of February proved to be below average with respect to precipitation but residents of British Columbia will find it difficult to forget the winter of 1934-35.

(2) Snowfall in the Capital City

Although the winter of 1934-35 was a wet and very troublesome winter, snowfall amounts over most of southwestern British Columbia remained far below records. Several winters experienced snowfalls surpassing totals amassed during that destructive winter and one of the more outstanding winters occurred almost twenty years earlier!

The first taste of sub-freezing temperatures during the winter of 1915-16 reached Vancouver on the night of the 28th of December. Snow followed the next day with two inches falling by the second of January. Colder temperatures remained in the wake of the snowfall and skies were generally clear. Snow began falling again on the sixth and by the 12th ten inches covered the ground. Sub-freezing temperatures remained through the month of January and into February easing up by the 10th. Snow totalling 62 inches had fallen on Vancouver since the New Year. The situation in Victoria did not differ greatly. With a low temperature of 15 above in January and a total of 30 inches of snow, Victorians were prepared for a moderating trend in February. This, however, was optimistic thinking on

the part of many Victoria residents. On the morning of the second the populace of the "City of Gardens" awoke to find nary a garden in sight. In fact, sidewalks and familiar landmarks were waist-deep in snow! The occasional hardy soul could be spotted tramping in the fleecy covering in snowshoes. Cars were found abandoned on the streets and street car service was stopped. Businesses remained closed and no supplies could be delivered. The Esquimalt and Nanaimo railway service connecting Victoria with up-island points was cancelled as snow drifts in many places reached depths of 70 inches or more! As only one snow plow was available, only one lane of the main thoroughfares was cleared mounding snow on both sides of the streets to heights greater than seven feet. Schools in the Greater Victoria area were closed due to the impassability of the roads and the difficulty in heating the classrooms. The roof of the mess hall at Willows Camp collapsed under the strain of the tremendous weight of snow. The camp housed about 3,000 men but fortunately no injuries were incurred. Lack of fuel resulted in men of the 88th Victoria Fusilliers and of the 67th Western Scottish of the Willows Camp having to search for driftwood along Willows Beach. The fire department was practically immobilized with the exception of horse-drawn wagons. Runners were added to the firewagons and additional horses were added to the brigade. Fire hydrants throughout the city were buried and, in case of emergencies, had to be dug out. Those who braved the waist-deep snow the first day of the storm, and managed to reach town, chose to stay overnight in local hotels rather than make the long trek home. Many residents found themselves short of fuel and fences and front steps were often sacrificed in order to keep warm and to cook. Children found themselves absolutely exhausted at the end of the day as sleighing, tobogganing, and snowshoeing were

prevalent throughout the city. A total of 46.4 inches of snow fell on Victoria in February making the total snowfall for the winter 77 inches! It was noted with interest that the storm at the beginning of February dumped a total of one and one-half million tons of snow on the Capital city! The snow fall set records at both Victoria and Vancouver and the yearly record of Victoria still stands today as do the February records for both localities.

(3) Winter, Sub-Zero Style

Noticeably lacking during the chaotic winters of 1934-35 and 1915-16 were extremely cold temperatures especially over the southwestern sections of the province. The winter of 1968-69 will long be remembered by residents of British Columbia, especially those of the Lower Mainland and Vancouver Island, as one of the coldest and longest winters in many years.

Hopes for a white Christmas over southwestern British Columbia in 1968 were dashed when temperatures hovered in the forties. The cold air, however, had been building up in the interior regions and sub-zero weather had gripped the central and the southern interior for weeks. Children in the lower mainland and Vancouver Island areas who received sleighs and toboggans for Christmas resigned themselves to the fact that their new toys will be little used this year. How absolutely wrong they were to be as the cold air suddenly poured out through the mountain passes on to the coastal regions on Boxing Day. Snow began falling on the evening of the 26th in Victoria and by the next day a total of 14 inches had been accumulated. Surprisingly only areas south of Ladysmith, just south of Nanaimo, were hit by the snowstorm. The sudden storm caught many people by surprise as they prepared to return to work after the holiday period. Several businesses remained closed and others

were forced to close because of the dangers accompanying the heavy snowfall. The Crystal Gardens, a glass enclosed, heated swimming pool in Victoria, was forced to close due to the weight of snow on the glass roof. Several panes had fallen through and others were leaking. Performances at the Christ Church Cathedral were cancelled and the Victoria City Hall remained closed for the day. The bitter icy wind continued to rush out of the mainland inlets plunging the temperatures to record lows. The mercury at Victoria sank to an icy 3.8 degrees while Vancouverites shivered at a temperature of 0.3 degrees below zero! As the cold air continued to deepen record minimum temperatures were set throughout the province. Penticton was paralysed in fifteen below weather, while the thermometer showed 29 below in Kamloops. Deeper in the cold air, Quesnel, in the Cariboo country, registered a frigid 41 degrees below! Residents along the Nechako River in the Central Interior were forced to evacuate their homes in the 40 degree below weather after ice-jams on the river caused flooding in the low lying areas. Many braved ten to twelve below weather in Duncan, on Vancouver Island, to skate on the frozen Cowichan Bay. Because of the snowfall before the frigid blast, many plants throughout the Lower Island area were saved. Milder air surged from the Pacific on New Year's Day and drove the arctic air back to the north. The milder air over the cold, snow-covered surface caused other problems, however, as fog formed resulting in the cancellation of several scheduled airlines flights. The slow thaw reduced the danger of flooding and children enjoyed the slush to the bitter end. After one week of mild, normal weather over southwestern British Columbia, the cold, arctic air built over the interior again and began spilling over on to the coast once more.

Green Island, just north of Prince Rupert on the north coast,

reported winds in excess of 100 miles per hour as the icy air roared out. In the south, the wintry blast rushed out through the Fraser Canyon and enveloped southwestern sections in its icy grip once again. In Vancouver the maximum temperature did not go above freezing from the 19th of January through to the end of the month. Almost twenty-five and one-half inches of snow fell on that city during the month while almost twenty-seven inches shrouded Victoria. Port Alberni on Vancouver Island reported a smothering 33 inches on the ground on the 15th of January. In the Fraser Valley, the wind-shipped snow drifted to depths of twelve feet, or more, and many homes became isolated. Fuel ran low and food supplies dwindled. A government icebreaker was sent up the Fraser River to New Westminster to keep the deep sea port free of ice. Further inland the Salmo-Creston highway was closed as slides blocked much of the road and 50 mile an hour winds made attempts at clearing the highway useless. The prairie-like weather continued to the end of the month and even the hardiest and the most enthusiastic tobogganists and sleighers had had their fill of frigid weather.

As with the end of most cold spells, gale force winds heralded the finis to the icy winter of 1968-69. Torrential rains along with gales washed the remaining vestiges of the wintry fleece. On the eighth of February winds reportedly as high as 83 miles per hour accompanying the milder temperatures lashed the west coast of Vancouver Island and dumped almost four inches of liquid sunshine on the "rain forest" area of British Columbia. Comox on the east coast of the Island recorded two and one half inches of precipitation with winds up to 65 miles per hour during the storm. Trial Island, just off Victoria, reported winds in excess of 80 miles per hour during the height of the blow, and ferry sailings crossing

the Gulf of Georgia were cancelled. The weather cooperated for the rest of the month of February, however, and provided little precipitation and large amounts of sunshine over the southwestern areas.

(4) Typhoon Freda

Winter storms are not the only destructive storms in British Columbia. In fact, more devastating disturbances occur during the spring and autumn months. High winds and pelting rain often combine to smash houses, trees, and down communication circuits causing thousands and, at times, millions of dollars of damage. One of the most damaging storms ever to have struck the Pacific Northwest was given the name "Typhoon Freda".

Two storms in rapid succession smashed into the Pacific Northwest during the 11th and 12th of October of 1962, causing damage amounting to the millions of dollars in British Columbia alone! In the early hours of the 11th a rapidly developing storm just off the Oregon coast battered the entire coastline from northern California to British Columbia with winds close to 90 miles per hour. Tracking swiftly northward the storm struck southwestern British Columbia during the afternoon increasing the winds from 16 miles per hour to 36, gusting to 58, in one hour at Victoria. Power blackouts occurred and many store windows were broken. Several trees were uprooted and a lamp standard in front of the Victoria city hall was bent as the wind caught the decorative banner commemorating Victoria's centennial. Winds in the Capital city reached 45 miles per hour with gusts to 70, while Vancouver, being a little more protected, reported winds of 40 to 55. Comox, on the east coast of Vancouver Island reported gusts to 80 miles per hour as the winds funnelled up the inlet. The storm quickly diminished shortly thereafter. As the Northwest recoiled after the first shattering blow, the second

storm wound up and began its delivery.

Two days earlier, the second storm had a rather inconspicuous beginning near Wake Island in the Pacific about 1,000 miles southeast of the coast of Japan. Increasing in intensity rapidly, the storm tracked in an east-north-easterly direction and was named "Typhoon Freda", a name which later was to be remembered by Northwest residents for years to come. As Freda crossed the International Dateline she registered a central pressure of 990 millibars and was positioned approximately 350 miles southwest of the Aleutians. However, by the afternoon of the tenth Freda had weakened to such an extent that she could no longer be considered a typhoon, and with a pressure of 992 millibars, she became an extra-tropical storm. Moving southeasterly and continuing to weaken, Freda, or more correctly, the extra tropical storm, filled to a pressure of 998 millibars. Then early in the morning of the 11th, while the first storm pounded the North American coastline, Freda stopped her weakening trend and suddenly picked up speed. By noon, she had moved an astounding 480 miles and her central pressure had now deepened to a pressure of 992 millibars! While only 650 miles from the California coast the storm swung eastward, much to the despair of California residents. Deepening further, the storm was rapidly growing to hurricane proportions as she changed direction once again and headed north-northeastward up the coast. By noon of the 12th, the rejuvenated storm registered a pressure of 976 millibars at its centre and possessed winds in excess of 100 miles per hour! Ships moored in the harbours in Oregon and Washington were literally ripped from their docks as the violent wind tossed them about like toys. Damage in Oregon alone had been estimated at $170 million with the major damage suffered by fruit growers and forest industries. The rapidly moving disturbance reached Washington by late afternoon and with 80 to 90 mile an hour winds, ripped trees down and tore communications and power lines down

throughout the state. The final tally in Washington showed a total of seven dead, and damage amounting to $60 million. Meanwhile, meteorologists in British Columbia had kept a close watch on the approaching storm and warnings had been issued for all coastal waters. At suppertime the wind at Victoria was still a light northeast although hurricane force winds were raging a few hundred miles away. Being a Friday evening, many residents were preparing to go out for the evening and few paid much attention to the weather warnings. Suddenly, the wind swung abruptly to the southeast and the speed increased to 34 miles per hour with gusts to 60! By 11 o'clock the howling winds reached a maximum sustained wind speed of 55 miles per hour with gusts to 89, and power lines were down throughout the city. Canadian Pacific telegraph circuits, along with press circuits and all news links with the outside world, were lost when a tree fell across communications lines to the north of Victoria. Long distance circuits from Victoria to Duncan and Nanaimo went out at 10:45 and the line to the mainland a short time later at 11:30. The British Columbia Ferries continued their Tsawassen to Swartz Bay run in spite of the weather, but encountered difficulty when docking resulting in the last two ferries being two hours late. The wind dies suddenly as the storm passed over the Capital city, but suddenly swung to the southwest and picked up speed again as the storm passed registering a maximum sustained speed of 56 miles per hour and a record gust of 90! With this parting blow Freda blew in several store windows including one at the T. Eaton and Company. A forty-two ton Martin Mars converted water bomber based at Patricia Airport was dragged 300 yards across the grass and tarmac after eight, one and one-half inch steel cables snapped under the strain. Its undercarriage was torn off, and the craft was finally flipped over on to its side. Two other small aircraft at the airport were damaged with one being a total loss. An unusual trick

was played by Freda in the View Royal area near Victoria. At the height of the storm, a carport with a fibreglass boat suspended from the ceiling was completely torn off the side of a house, lifted clear over the house and sent smashing into the house next door! Although the occupants of the house were sound asleep, and the carport crashed through the bedrooms, there were, miraculously, no serious injuries. By three o'clock the wind in Victoria had subsided to a sedate six miles per hour.

Vancouver, although more sheltered than Victoria, was not spared. Reporting a wind of 10 miles per hour at eight during the evening, Vancouver was ravaged by a howling 50 to 65 mile an hour gale three hours later. The maximum sustained speed recorded at Vancouver was 54 miles per hour with a peak gust of 78 miles per hour. In less than one hour the effects of the storm travelled from Victoria to Vancouver which shows the tremendous speed at which the storm was travelling. No heavy seas were reported because of the sudden intensification and rapid movement of the storm, and consequently no major vessels were reported lost. As the storm passed over Vancouver, the lowest pressure was recorded at 975 millibars. With her energy spent, Freda, or what was left of her, limped northward and split into two centres. Damage sustained in British Columbia was in excess of ten million dollars and seven deaths were attributed to the storm. The awesome, devastating power of Freda will long be remembered by residents of the Pacific Northwest.

(5) <u>Hail in the Okanagan</u>

Storms need not be widespread to be destructive. Some violent weather is confined only to very small areas as is demonstrated in the case of tornadoes. British Columbians have had their share of severe weather but few have experienced the destruction of a violent hailstorm.

The 29th of July in 1946 had been a warm day and the sun was creeping toward the western horizon when workers in the orchards near Penticton noticed a towering black, ominous-looking cloud building in the west. There was a sudden chill, and a few drops of rain fell. Summer showers were not uncommon, and the workers continued their assigned tasks disregarding the dark mass. Orchard workers in the Summerland District also noticed the churning giant, but there was one difference: the cloud seemed to be building in the south. Quickly the dark heap converged on the area. A chilling, gusty wind began to blow and the large drops of rain began pelting down on the hundreds of farm lands in the fields and orchards, followed by a distinct roaring sound. Instinctively, the workers scurried for shelter as the sky all but disappeared, obscured by the black veil. As the first few labourers reached the safety of the farmhouses the full fury of the storm stuck. Hailstones as large as eggs bombarded the orchards ripping and tearing at the unripe fruit and vegetables. Branches were stripped and even plants in greenhouses were smashed as the stones tore through the glass structures. Although the hailstones pounded relentlessly on the scurrying workers, none suffered injuries more serious than bruises and minor cuts. The storm completely pulverized what was to be a record fruit crop while farmers watched helplessly. Suddenly, it was over. The sun began to shine again as workers waded through the pulpy mess of smashed fruit. Everywhere was the look of desolation. The storm, as if unsatisfied with the destruction performed on the Summerland area continued its devastating northeasterly trek, sparing Peachland but smashing a swath across Lake Okanagan to Okanagan Mission, then through the Kelowna, Rutland, and Winfield areas, before dissipating to the northeast. In the wake of what was to be the most destructive single storm in the history of the Okanagan Valley was damage totalling $1,700,000. Approximately ten percent of all apples, peaches, prunes, and apricots, and 15 per-

cent of the pear crop, as well as five percent of the crabapples were destroyed by the fifteen minute storm. Some of the hailstones measured over two inches in diameter and weighed over two ounces. Glass in most homes in Summerland district was broken by the missiles, and over a million packages of fruit and vegetables were pureed in the Rutland-Winfield region. Many farmers still remember the hail storm of 1946 and shudder at the thought of a repeat performance.

(6) The Cariboo Tornado

An extremely close relative to the hailstorm is the tornado. Although occurrences of the "twisters" in British Columbia are rare, there have been documented reports of such events. Awesome and devastating, these violent storms may cause thousands of dollars of damage in a matter of seconds. One such event documented in the weather annals of the province occurred in the Central Interior of British Columbia during a hot summer afternoon in 1926.

Temperatures in the Cariboo region of British Columbia were extremely high during the first few days of July in 1926 and had inched into the mid-nineties in the afternoon of the 12th. Residents of the area sat around talking and discussing the unusually hot and sultry conditions as no work could be performed under these uncomfortable conditions. It was disconcertingly quiet and calm. Suddenly, a large dark cloud loomed up on the southwestern horizon near 115 Mile House on Lac La Hache and a snake-like extension formed beneath the black, towering cloud and plunged earthward. Within moments the air was shattered by the deafening roar of a tornado! Rain pelted down in curtains flooding the land as the sound of cracking thunder reverberated throughout the area. As far away as 127 Mile House the thunder was described as the sound of "...the bursting of cannon". Barns and many other structures literally disintegrated as the storm swept down on them. Stands of valuable timber

were mowed down like grass and bolts of lightning started many fires in the tinder-dry forests. Almost all power lines were downed and roads into the area were impassable because of the fallen timber. Many cattle were killed as they grazed in the pastures, and a recently finished irrigation ditch was completely destroyed. In a matter of a few minutes the violent storm caused many thousands of dollars of damage to property, timber, and homes. Then, as rapidly as it started, the storm moved on, dissipating as its energy was spent.

(7) An Earlier Centennial Summer

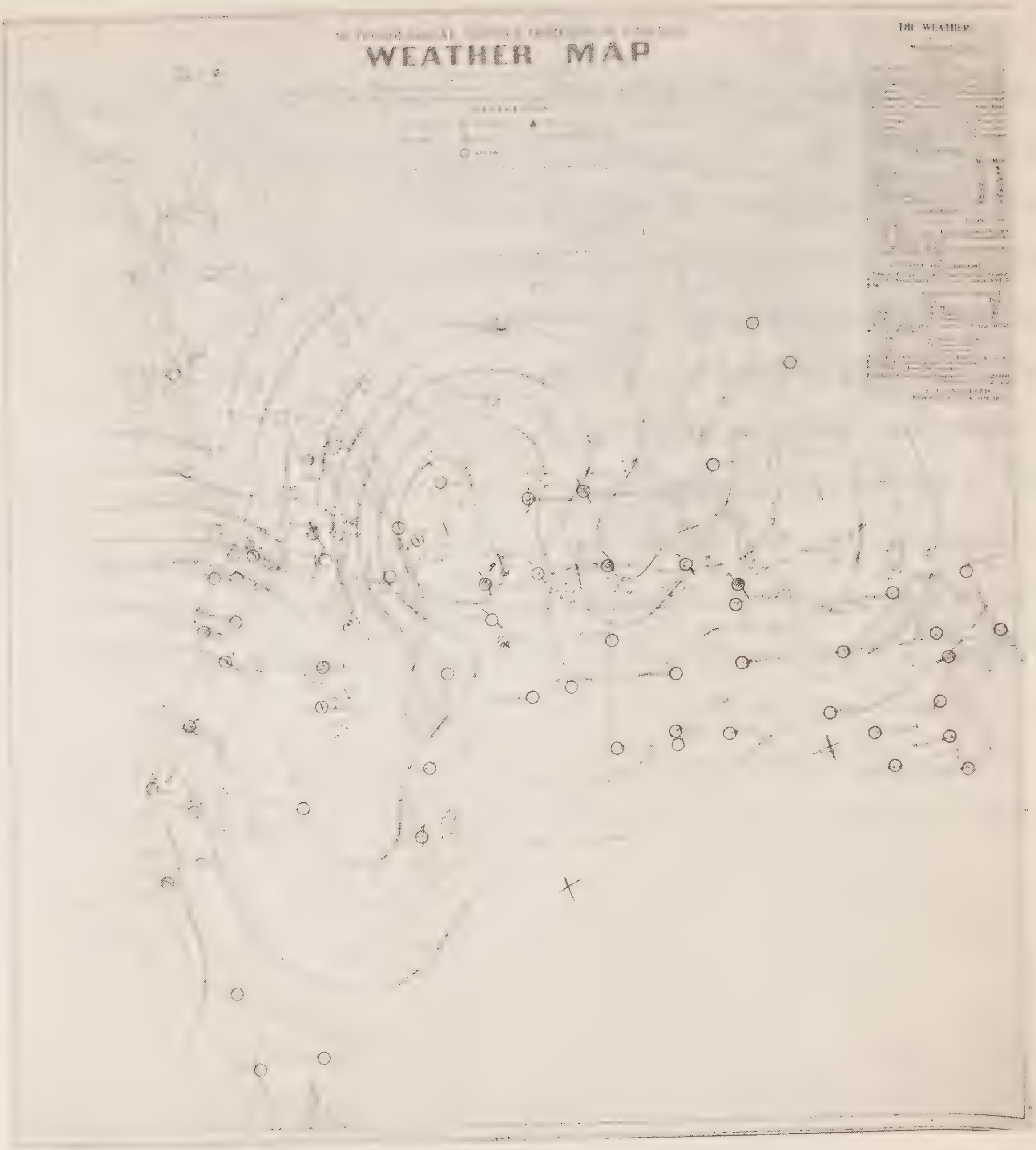
Weather records are not always concerned with violent and tempestuous manifestations in the atmosphere. Quite often periods of meteorological significance are notable due to their lack of activity. Many summers in British Columbia have been warm and dry but few can compare with the arid summer of 1958, the centennial year for the province. Celebrations began early in the year with the unseasonably warm winter but the major spectacular events were scheduled for the summer months. Summer actually commenced during the latter part of April with the cessation of the spring rains and with only the occasional shower to dampen the forests, serious fire hazards developed over large sections of the province. Lightning storms touched off several fires in the Interior and caused many thousands of dollars of damage. These fires were a prelude to the explosive situation which was to develop during the remainder of the summer. Festivities and outdoor shows were numerous during the latter part of June and July, as centennial celebrations got well underway. Few dared to think of rain. An exception were the men of the British Columbia Forest Service who maintained a constant watch on the tinder-dry forests of the province. With each mounting day without rain, the forest fire hazards soared, and in many sections of the province the Forest Service

imposed restrictions to travel. Evidence of the drought conditions was noticed as many customarily green lawns in the cities had suddenly become a parched beige. The entire month of July was rainless over most of the coast, and even the normally wet Queen Charlotte Islands reported only a mere one-hundredth of an inch of rain between the 10th of June and the 19th of July. Despite the rigid controls imposed by the Forest Service and the individual logging companies, fires sprang up throughout the province in major proportions. Widespread lightning activity in the Prince Rupert area, normally a low lightning fire risk area, instigated over 160 conflagrations during the first week of July. It was estimated that, for a period of time in July, over one million acres of forest land were aflame over the northern half of the province while a somewhat lesser area burned over the southern sections. Fanned by gusty winds, the fires ravaged the land, and in many cases over-running fire suppression camps. The hot and dry weather continued into August and with the exception of a few light showers maintained the dehydration of the forests. The fire situation remained critical until the automn rains in September.

For the centennial celebrations the weather seemed tailor-made as sunshine records for the month of July were set in many offices throughout the province. Victoria recorded a total of 424.7 hours for the month of July, surpassing the previous record set in 1899 by 30 hours! With the pleasant statistics, there are also the grim figures presented by the Forest Service. Over two million acres of timber land lay under blackened ruins with damage totalling nearly eight million dollars. The firefighting costs amounted to over four and one-half million dollars, or about five times the average. Fortunately, 75 percent of the area burned included non-productive sites and areas of non-commercial cover.

With such diversity in weather in British Columbia it is

evident that weather predicting in this area can often very very troublesome. Great variations in topography from the Okanagan Valley to the mountainous Kootenays and the rugged coastal sections all contribute to the dissimilarity of weather experienced over different areas of the province. Devastating storms such as Typhoon Freda are usually confined to the coastal areas while violent thunderstorms, hailstorms and, in some extreme cases, tornadoes tend to be restricted to the interior parts of the province. Many problems found in weather forecasting have been slowly overcome but many of them remain unsolved. It is only with increased knowledge gained from years of experience and research that the quest for a consistently perfect forecast can be successful.



WEATHER MAP — MARCH 1, 1899

Fig. 6·1

SNOW SCENES IN VICTORIA — FEBRUARY, 1916

Fig. 6·2

WEATHER MAP — FEBRUARY 1, 1916

Fig. 6·3

ICE STORM IN CHILLIWACK – JANUARY 1935

Fig. 6·4

WEATHER MAP — JANUARY 16, 1935

Fig. 6·5